Nature Coast Aquatic Preserve Seagrass Monitoring Program: 2022 Report

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Aquatic preserves (APs) are established by law as exceptional areas of submerged lands and associated waters that are to be maintained in their natural or existing conditions. The intent is to forever set aside submerged lands with exceptional biological, aesthetic, and scientific values as sanctuaries for the benefit of future generations. The Nature Coast Aquatic Preserve (NCAP) is the newest aquatic preserve and was signed into law (HB 1061) by Governor Ron DeSantis in June 2020. One of the hallmarks of this preserve is its extensive seagrass meadows. Herein, we detail findings related to the newly established seagrass monitoring program.

Keywords: seagrass, phosphorous, percent cover, environmental drivers

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Background

Seagrass beds are incredibly important ecologically and economically. Seagrasses improve water clarity by stabilizing bottom sediments and absorbing nutrients from the water column. They reduce coastal erosion by helping to diffuse wave energy during storm events and function as an important habitat. Economically, seagrass beds are of critical importance to Florida's commercial and recreational fisheries. Florida's juvenile fish and invertebrates (e.g., red drum, shrimp, bay scallops, seatrout, mullet, and stone crabs) depend on seagrasses for food and protection. Manatees, wading birds, and sea turtles also use these areas for foraging.

Major threats to seagrasses in this region include propeller scars, large storms, and increases in nutrient loads. Natural threats, like hurricanes, can cause fragmentation of seagrass beds that can take years to heal. Disruption of seagrass from interactions with boat propellors also fragments seagrass meadows. Deep scars or areas with repetitive propeller scars will often not recover on their own and require restoration. Another threat to seagrass is nutrient loading from rivers which can decrease water clarity and shade out sunlight that grasses need for photosynthesis. Since water itself also attenuates light, seagrasses in deeper water may be more susceptible to issues associated with increases in nutrients. At high nutrient loads, algae can proliferate more quickly than seagrasses and community may shift from seagrass dominated to algal dominated where algae block light from seagrasses (Burkholder et al. 2007). Finally, seagrass growing on the Gulf Coast of the Florida peninsula show variation in morphology, shoot density, growth rates, and elemental composition in relation to a gradient in water column total phosphorous concentrations. Areas with higher total phosphorous produced taller shoots with wide leaves, and shoots were less dense. This is evidence that seagrasses balance shoot morphology and density in relation to phosphorous to maintain growth and survival across a wide range of nutrient supply (Barry et al. 2017) and also suggests that as nutrient levels increase, observable changes may happen before seagrasses are lost and before the plant community shifts towards algae.

Regular, long-term monitoring of seagrasses can help to identify trends and indicators of seagrass stress before loss, while threats are still potentially reversible. When plants die back, nutrients once stored in the plant tissue are released into the water. Sediment, once held in place by roots and rhizomes, can be resuspended causing increased turbidity and reduced light. This shift in environmental condition is considered a negative feedback since the new conditions are ones where it is difficult to re-establish seagrasses. This means that identifying and mitigating threats early increases the likelihood of being able to effectively manage these habitats.

The Gulf of Mexico Seagrass Monitoring Community of Practice suggests a tiered approach of seagrass monitoring (Hanley et al. 2020). Tier 1 characterizes few ecosystem properties at a large spatial scale typically using ground-truthed aerial imagery. The metric produced is typically areal coverage. Tier 2 monitoring should occur more often and at a finer spatial resolution and should result in metrics such as seagrass percent cover, precent cover by species, as well as environmental characterizations such as water depth, light attenuation, and salinity. Tier 3 is often at an even finer spatial scale and is used for specific hypothesis testing. In NCAP, Southwest Florida Water Management District (SWFWMD) conducts tier 1 monitoring every 4 years (SWFWMD 2022). The data presented here (DEP funded and UF collected) represented tier 2 monitoring. And the UF team is helping with ongoing research projects representing tier 3 monitoring.

Methods

Site selection

The NCAP seagrass monitoring program was newly initiated in 2021 and did not draw upon any previously established stations or historical monitoring programs. The UF team selected sampling stations using a stratified random sampling design, where Project COAST stations that met certain criteria were used as sampling strata. Four estuarine systems were selected as the main sampling areas: Crystal River, Weeki Wachee, Pithlachascotee, and Anclote. The selection of these four estuarine systems was because Crystal River and Weeki Wachee span a historical phosphorus gradient previously identified in the region (Barry et al. 2017) and bracket the longest running core Project COAST sites (Jacoby et al. 2015). They also provided a convenient geographic distribution across the northern and central NCAP, without duplicating effort in the adjacent St. Martins Marsh Aquatic Preserve. The selection of Pithlachascotee and Anclote rounded out the sampling systems by providing geographical bracketing of the southern end of the NCAP and drew upon initial observations that these systems contained the bulk of seagrass resources from the four estuarine systems in Pasco County.

For each estuarine system specific site coordinates (Appendix A) were generated by first examining long-term salinities at Project COAST stations in each of the four estuarine systems. Long-term salinities were calculated as means of the period of record from historical Project COAST data. We excluded any Project COAST stations with a long-term mean of less than 15 ppt, based on the biological tolerances of seagrass species we expected to observe (Doering and Chamberlain, 2000; van Tussenbroek et al., 2007). We then examined geographic locations of the remaining Project COAST stations and excluded any stations that did not fall into an AP boundary (NCAP, SMMAP, BBSAP, PCAP). Finally, we examined historical records from past seagrass sampling (Jacoby and Frazer, 2013) in Crystal River and Weeki Wachee, and further excluded Project COAST stations where seagrass was not observed at least once in the six sampling events from 2010–2012. The remaining Project COAST stations were buffered with a 1km circular buffer and we clipped out land area from the resulting buffers using the “County Boundary 2015” shapefile available publicly online. We then generated at least 30 random points within each estuarine system, equally distributed among the candidate buffers and where points were forced to be at least 100 meters apart. We selected the top 25 stations from each river station based on random number generator to create the rankings. We then ground-truthed these 25 stations in each of four estuarine systems during the first sampling events in June–July 2021. The final 100 points are presented Appendix A. Sample selection procedures were carried out using Microsoft Excel 365 and ArcMap 10.8.1 (ESRI).

Field Surveys
Field protocols were designed to match adjacent AP protocols to facilitate future comparisons. Field protocols are the same, except that the NCAP team added recording canopy heights of seagrass species. Estimates of total cover between team members of both programs were calibrated by comparing estimates of percent cover of the same quadrats. If team members were not within 5% of their estimates of percent cover, rationale of estimates was discussed by the group until consensus was reached. Going forward, the rationale agreed upon was used in future estimates. Approximately 10 quadrats were observed by team members during this calibration day, and estimates were typically within 5%.

The field team navigated to seagrass monitoring stations using a Garmin GPS and anchored the boat within 10 feet of the site. At each site, the team measured total water depth using a marked pole or weighted transect tape and documented water temperature, dissolved oxygen, salinity, and pH using a handheld YSI Pro DSS datalogger. The handheld datalogger was calibrated and maintained in accordance with the approved Seagrass Monitoring SOP. At stations where the bottom was not visible, a Secchi depth reading was taken. Team members assessed four randomly placed 1 m^2 quadrats using the four corners of the boat as a reference point. For each quadrat, team members recorded total drift algae cover, presence of seagrass and macroalgae species, total cover of seagrass and macroalgae as well as individual cover of each species present, presence of scallops and urchins, three measurements of canopy height (to the nearest cm) of up to three dominant seagrass species, epiphyte density, and sediment type. This represents a shift from 2021 procedures where previously a modified 6-point Braun Blanquet scale was used to describe cover instead of the more precise method of estimating percent cover. This change was also adopted by adjacent AP seagrass monitoring programs. If any propeller scars or engine blow-outs were observed within a quadrat, that information is recorded in the notes section of the datasheet. At the end of each field day (Table 1), a CCV was performed on the YSI and field data sheets were stored at the Reynold's Lab.

Data Management
Data from the seagrass field assessments were entered into an Excel spreadsheet formatted from an existing file approved for upload into the Statewide Ecosystem Assessment of Coastal and Aquatic Resources Data Discovery Interface (SEACAR DDI). Each line of data in the spreadsheet was quality checked and stored in a Dropbox folder with access restricted to the NCAP team only. Once all NCAP team members reviewed the file, it was uploaded into the SEACAR DDI under Program 560— Big Bend Seagrasses & Nature Coast Aquatic Preserves – Seagrass Monitoring. This program page includes the revised GPS coordinates excel file: GPS Coordinates for BBSAP and NCAP Stations and the updated Standard Operating Procedure document: NCAP SOP – Seagrass Monitoring Program. Proof of program edits and file uploads are included in the report (Appendix B).

Data Analysis

Environmental Data
Basic environmental data were plotted by latitude and estuarine system to visualize patterns. Differences across estuarine systems were analyzed using ANOVA followed up by Tukey's honestly squared difference (HSD) multiple comparison procedure. Normality of the residuals was checked with the Shapiro-Wilk test and data transformations applied where possible to correct for violations of

assumptions of parametric analysis. All analyses were carried out using R Studio version 1.4 (R Core Team, 2021).

Quadrat Data
Seagrass data were plotted by estuarine system to visualize patterns. Differences across estuarine systems were analyzed using ANOVA followed up by Tukey's honestly squared difference (HSD) multiple comparison procedure. Normality of the residuals was checked with the Shapiro-Wilk test and data transformations applied where possible to correct for violations of assumptions of parametric analysis. All analyses were carried out using R Studio version 2.3 (R Core Team, 2022).

We performed multiple regressions to examine relationships between environmental variables and total SAV cover, seagrass cover, and macroalgae cover. We also examined differences in coverage values for each class across estuarine systems and in relation to water quality variables known to affect SAV establishment and growth (TN, TP, color, chlorophyll, and depth). Water quality data for analyses were the values generated from May 2021–May 2022 from the nearest Project COAST station.

We explored the relationship between epiphyte cover and canopy heights for the three meadow-forming seagrass species (*Thalassia testudinum*, *Syringodium filiforme*, and *Halodule wrightii*) against depth, and water quality variables (TN, TP, color, chlorophyll) using multiple regression.

We also explored the SAV community using univariate metrics of species diversity (raw species richness, Shannon-Weiner diversity calculated using percent cover scores) that were compared among estuarine systems using one-way ANOVA. Normality of the residuals was checked with the Shapiro-Wilk test and data transformations applied where possible to correct for violations of assumptions of parametric analysis.

We also explored SAV community data in multivariate space using non-metric multidimensional scaling (nMDS). The raw data frame considered for nMDS analysis consisted of the precent cover for each species from all four quadrats deployed at a station. Before analysis, all stations with no SAV (i.e., bare stations) were removed from the data set. Data were then standardized to presence-absence (binary) scale using R package vegan (Oksanen et al., 2022) and the resulting matrix was passed to the metaMDS function. Jaccard distance was chosen as the analysis metric (Salako et al., 2013). An initial run of metaMDS was run with dimensions (k) set to 2 and the best solution was fed into a second run of metaMDS with the same settings. The resulting solution was plotted in dimensionless multivariate space so patterns in the SAV community across estuarine systems could be visualized. All analyses were carried out using R Studio version 1.4 (R Core Team, 2022).

Results

Environmental data
Data on temperature, salinity, dissolved oxygen, pH, and depth were collected and compiled for all 100 sampling stations. Temperature ranged from 26.5 to 31.2 °C, salinity ranged from 11.3 to 32.58 ppt, dissolved oxygen ranged from 3 to 10.75 mg/L, and pH ranged from 7.6 to 8.83. In general, there were observable spatial differences in temperature (Figure 2) and salinity (Figure 3). Temperature varied with latitude in a somewhat predictable manner, where average temperatures tended to be higher in the more southern systems (Figure 2). Salinities varied such that Weeki Wachee was noticeably less saline and Anclote somewhat more saline than either Crystal or Pithlachascotee (Figure 3). Dissolved oxygen (Figure 4) and pH (Figure 5) tended to exhibit less spatial variation. While Crystal had statistically lower DO and pH values than the other sites, differences were small.

Depths at seagrass sampling stations ranged from 0.2 to 3.9 m. While there were no statistical differences in depth across the study region, Anclote tended to be slightly deeper overall due to several stations that exceeded 2 m in depth (Figure 6).

Finally, examination of Project COAST data from May 2021–May 2022 suggests that, at least in the short-term, submerged aquatic vegetation (SAV) in Pithlachascotee and Weeki Wachee experience relatively higher total nitrogen concentrations while those in Weeki Wachee experience lower total phosphorus concentrations in comparison with other systems (Figure 7a, 7b). Overall, concentrations of grab samples for total nitrogen collected in from May 2021–May 2022 ranged from 140 to 870 µg/L and those for total phosphorus ranged from 2 to 69 µg/L. Chlorophyll ranged from 0 to 20 µg/L. For most of the year, values were uniformly low; however, there were a few higher values especially in summer with highest values found in Crystal (Figure 7c). Color concentration (range 0.1 to 58.9) was slightly higher overall in Pithlachascotee and Crystal (Figure 7d).

Quadrat data
During the 2022 sampling, we collected data from 400 quadrats spread across the 100 sites in each of the 4 systems. Excluding drift algae, we identified seagrasses and macroalgae from 21 different taxa across the four systems (Table 2). Five of these were seagrasses, and all five seagrass species were found in Crystal (Table 2). There were 16 species of attached macroalgae, many of which were green calcifying varieties in the genera *Penicillus, Halimeda, Udotea,* and *Acetabularia* or one of five types of fleshy green algae in the genus *Caulerpa*. Crystal River exhibited the highest overall total richness (19 taxa) and the highest macroalgal richness (13 taxa, Table 2). However, mean richness was statically similar at all sites expect Anclote, which was the lowest (Figure 8). Mean diversity measured as H' was highest in Crystal, lowest in Anclote, and intermediate at Pithlachascotee and Weeki (Figure 8).

Thalassia testudinum, the climax seagrass species, was the most prevalent seagrass in both Pithlachascotee and Weeki Wachee, where it was present in over 90% of the quadrats (Table 2). *Halodule wrightii*, considered a more pioneering species, was the seagrass found in most quadrats in Crystal (56%) and in Anclote (42%). Anclote was the system with the highest proportion of bare quadrats, with 23 out of 100 quads lacking vegetation (Table 2). There were few differences in epiphytes found on seagrasses across systems, but Anclote did have statistically lower epiphyte cover than Crystal with the other sites being intermediate and statistically similar to both Anclote and Crystal. When epiphyte scores were examined in a multiple regression with water quality (TN, TP, Color, chlorophyll) and water depth, only water depth showed a significant negative relationship ($F_{5,89}$=2.342, p=0.047).

Percent cover for total SAV coverage, seagrass coverage, and macroalgae coverage yielded significant differences among systems. Total SAV coverage was highest in Pithlachascotee, intermediate in Crystal and Weeki Wachee, and lowest in Anclote (Table 3, Figure 9). Seagrass cover was significantly higher in Pithlachascotee while macroalgae cover was higher in Crystal (Table 3, Figure 9). The lowest mean total SAV coverage was 38.6% in Anclote the highest mean cover was 78.5% in Pithlachascotee. Using a multiple regression approach with variables of water depth, salinity, temperature, dissolved oxygen, and pH, we found that both total SAV cover ($F_{5.94}$=8.416 p<.0001) and total seagrass ($F_{5.94}$=7.52 p<.0001) were negatively related to water depth and positively related to temperature, while macroalgae cover ($F_{5.94}$=9.138 p<.0001) was positively related to temperature and negative related to pH. When plant cover was examined in multiple regressions with water quality variables derived from Project COAST (TN, TP, color, chlorophyll, and water depth), total SAV ($F_{5.94}$=3.594 p=0.005) showed a negative relationship with TN and water depth and a positive relationship with color while total seagrass cover ($F_{5.94}$=8.079 p<.0001) was positively related to TP and color and negatively related to chlorophyll and depth. Macroalgae cover ($F_{5.94}$=9.978 p<.0001) was only positively correlated with chlorophyll.

Mean canopy height showed significant spatial variation across systems for each of the three seagrass species examined (Figure 8a-8c). In general plants were tallest in Anclote and Pithlachascotee, shortest in Weeki Wachee, and intermediate in Crystal. The exceptions were that *Syringodium filiforme* was not observed in Weeki Wachee, and *Halodule wrightii* canopies were similar in Anclote Pithlachascotee and Crystal. Using a multiple regression approach with water quality variables derived from Project COAST (TN, TP, color, chlorophyll, and water depth). *Thalassia* ($F_{5,64}$=7.661 p<0.001) and *Halodule* ($F_{5,61}$=12.64 p<0.001) canopy heights were negatively related to TN and chlorophyll and positively related to TP and color. We found no relationship between TN, TP, color, chlorophyll, and water depth with *Syringodium.*

Visualization of SAV community composition using nMDS shows a high level of overlap, but some separation is evident especially between Pithlachascotee and Weeki Wachee, which have minimal overlap in multivariate space. Crystal exhibits a high degree of overlap with both Anclote and Pithlachascotee, and only minimal overlap with Weeki Wachee (Figure 10).

While seagrass scars were observed in the general sampling area, none were observed within the quadrats at the time of the assessment.

Discussion

With these data, we document a vibrant seagrass community with impressive diversity both within and between estuarine systems. There are seven species of seagrass in Florida, and we find five of those within the Nature Coast Aquatic Preserve. Additionally, we documented 16 species of attached algae and document abundant drift algae which represents several genera. This taxonomic diversity was not spread evenly across estuarine systems. In addition to community composition, plants varied in percent cover and in canopy height amongst estuarine systems. Plant variability is likely driven by environmental variability. Environmental factors such as nutrient concentrations, color, temperature, chlorophyll, and salinity all showed evidence of spatial differences within the study region, while other factors such as dissolved oxygen, pH, and water depth exhibited minimal spatial differences.

These data represent a shift from using categorical Braun Blanquet scores (in past AP monitoring and in NCAP 2021 monitoring) to continuous percent cover estimates of seagrass cover, and this shift coincides with clearer predictors of plant cover and morphology. In 2021 when cover was described by Braun Blanquet, environmental data were not able to predict total SAV or seagrass cover, but with the 2022 data, total SAV cover, total seagrass cover, and canopy height were significantly predicted by several variables in ways that are intuitive. Plant cover was reduced in deeper water where light may be limited. In this phosphorous limited system (Barry et al. 2017), we see positive relationships with cover and canopy height and phosphorous concentration.

Another potential reason for stronger relationships in 2022 than in 2021 is that there were more water quality data to use. Water quality monitoring started again in March 2021, so in 2021, we only used water quality in the previous month to predict seagrass cover. In 2022, we used water quality from the previous year as explanatory variables. Past work has shown that seagrasses may respond to water quality conditions integrated over the course of years (e.g., van Tussenbroek, 1996). This highlights the importance of regular, long term, and coordinated seagrass and water quality monitoring programs.

Not all of the significant relationships are easily interpreted. In multiple regressions, TN was a significant negative predictor of plant cover and canopy height, and color exhibited positive relationships with plant cover and height. TN and TP exhibit opposite patterns in these systems. Weeki has the lowest TP and the highest TN while Crystal has the highest TP and the lowest TN. Since this these estuaries tend to be phosphorous limited, it is likely that the TP is diving the patterns and that the relationship with TN is due to multicollinearity; however, manipulative experiments would be needed to fully understand that relationship. Color should represent low light and be stressful to seagrasses, but in general color values are low and thus are likely not stressful. Color instead may be related to high rain events and nutrient delivery that is impacting seagrass performance. Further, because we have a limited dataset, patterns can be influenced heavily by episodic events. Our power to interpret patterns that may robustly inform decision-making will be improved over time with the addition of subsequent years of data.

While some correlations need further investigation, these documented correlations provide some promising avenues for early warning indicators. In multiple regressions, TP is a significant contributor to seagrass parameters (cover and height). Currently, TP is relatively low in these systems so these relationships are positive. Shifts in TP, in seagrass height, or in seagrass cover are likely to occur and be observable before seagrasses are negatively impacted by high nutrient concentrations — as is happening in other parts of Florida, and in fact, all over the world (Waycott et al. 2009). Furthermore, the analyses undertaken herein represent only a subset of those possible. For example, we did not examine percent scores in relation to environmental factors for individual taxa nor did we perform any multivariate statistics or mapping. Looking ahead, we anticipate that new insights will emerge through collaboration with partners and DEP staff, who may conduct further analyses using raw data available through the SEACAR portal.

Conclusions

These data document a diverse seagrass assemblage with relatively high cover, and the SWFWMD data document large expanses of seagrass that are stable or even expanding (Sherwood et al. 2017, SWFWMD 2022). Together these data point to a vibrant and healthy seagrass system within NCAP. It is important to note that both of these data approaches are important and complement one another. The quadrat sampling may be biased toward dense seagrass and miss loss in places such as the deep edge which will be more accurately captured by the areal imagery. However, the areal imagery does not capture the detail (change in height and cover) like the quadrat data do. Both of these data monitoring programs are essential to accurately describing status and trends in NCAP seagrasses.

While these data are important in documenting the status of seagrasses within NCAP, we still know little about variability between years, so data should be interpreted with some caution. Trend analyses will be possible with the continuation of this monitoring program.

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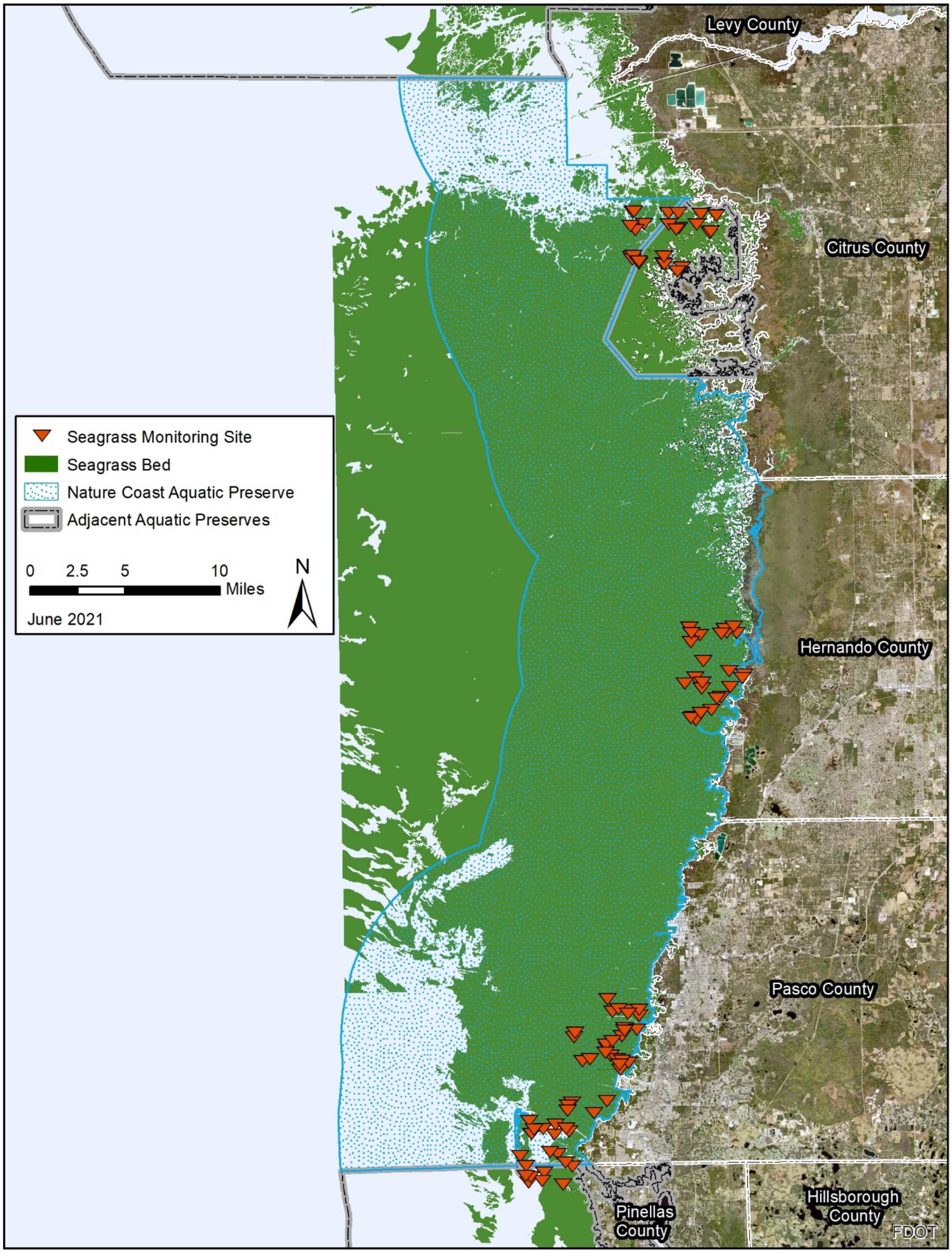

Figure 1. Map of the Nature Coast Aquatic Preserve and seagrass monitoring locations associated with this report.

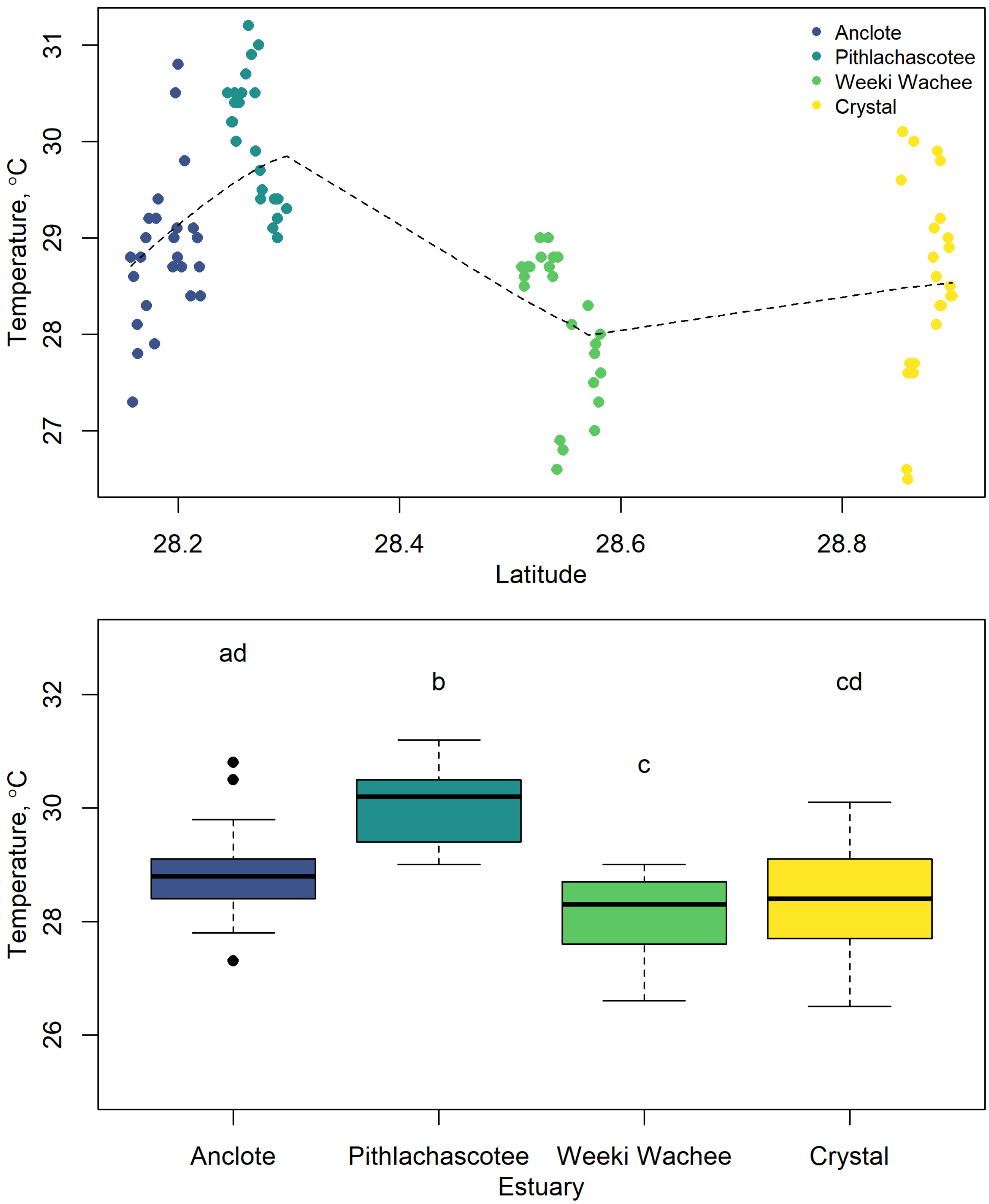

Figure 2. Temperature data collected during seagrass monitoring events in 2022. Letters above boxes in lower panel represent statistically significant groupings revealed by the Tukey's post-hoc comparisons.

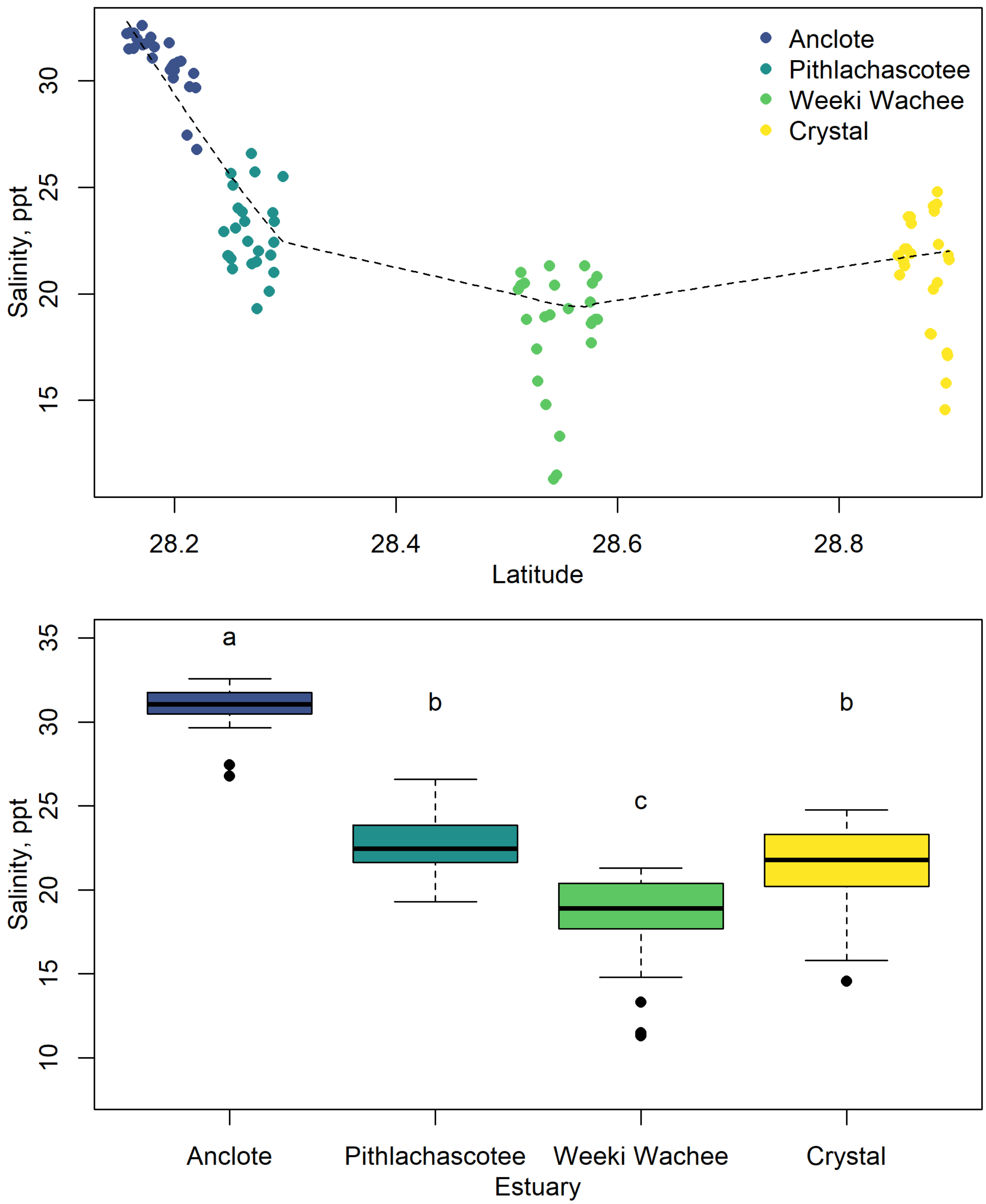

Figure 3. Salinity data collected during seagrass monitoring events in 2022. Letters above boxes in lower panel represent statistically significant groupings revealed by the Tukey's post-hoc comparisons.

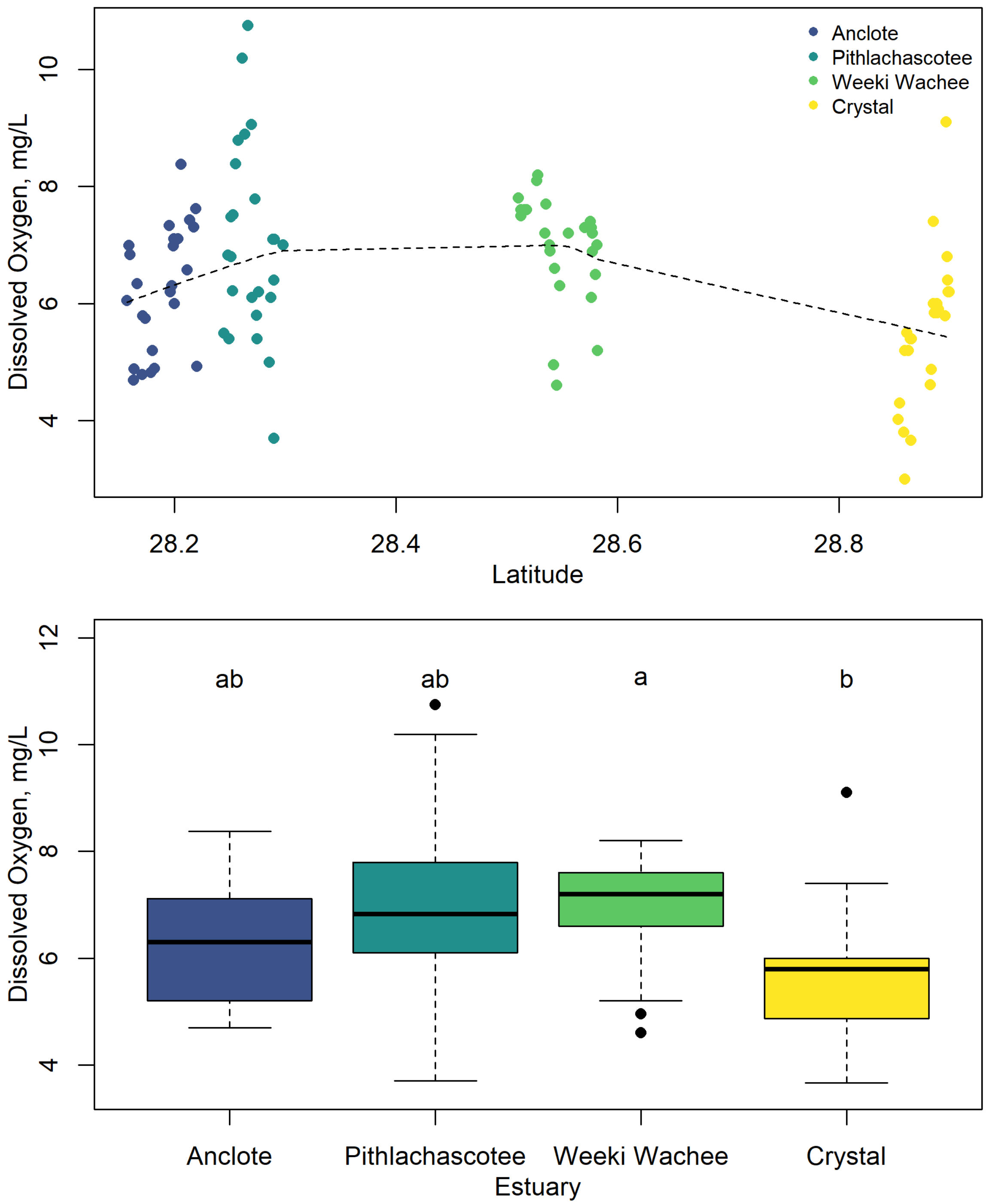

Figure 4. Dissolved oxygen data collected during seagrass monitoring events in 2022. Letters above boxes in lower panel represent statistically significant groupings revealed by the Tukey's post-hoc comparisons.

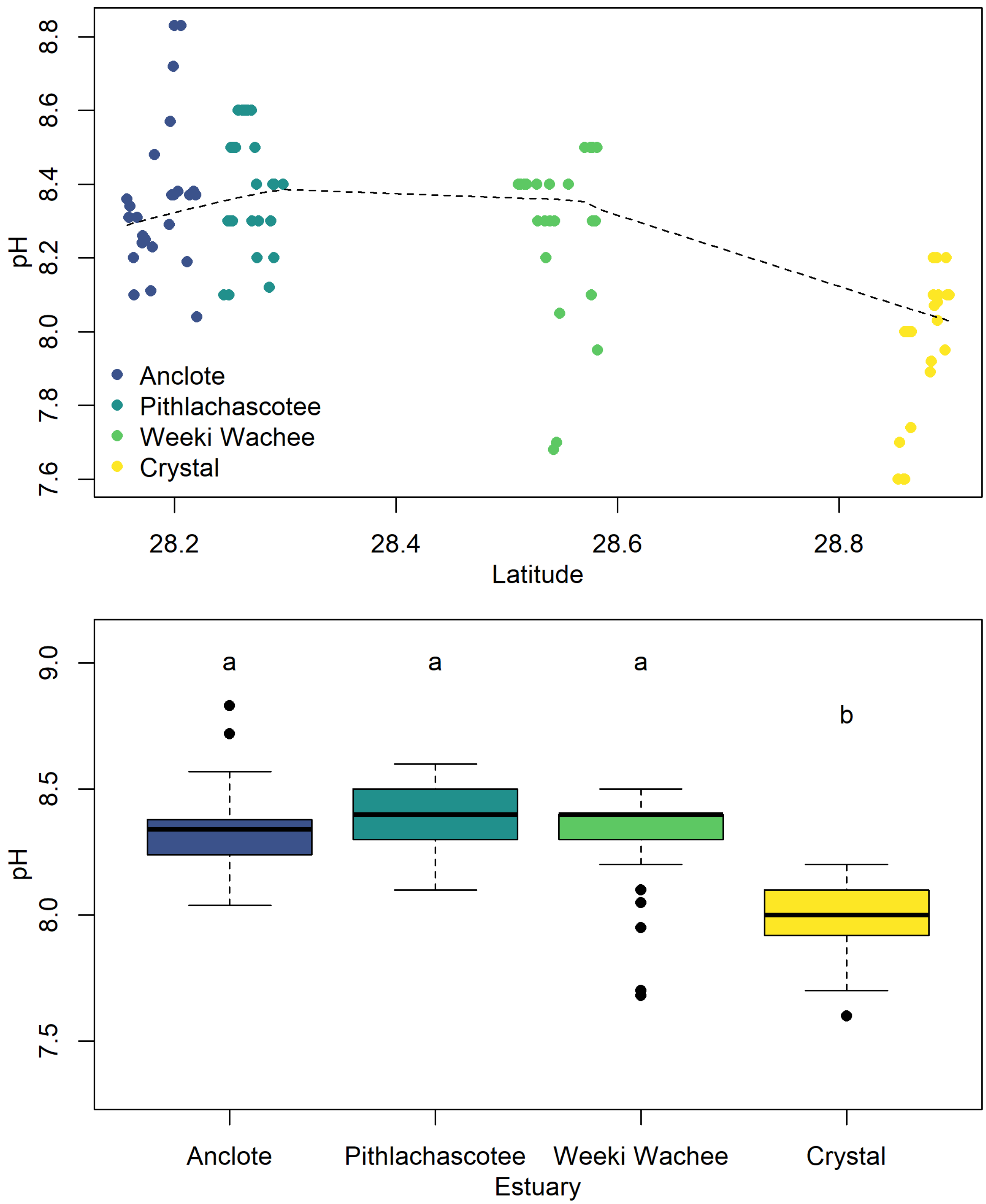

Figure 5. pH data collected during seagrass monitoring events in 2022. Letters above boxes in lower panel represent statistically significant groupings revealed by the Tukey's post-hoc comparisons.

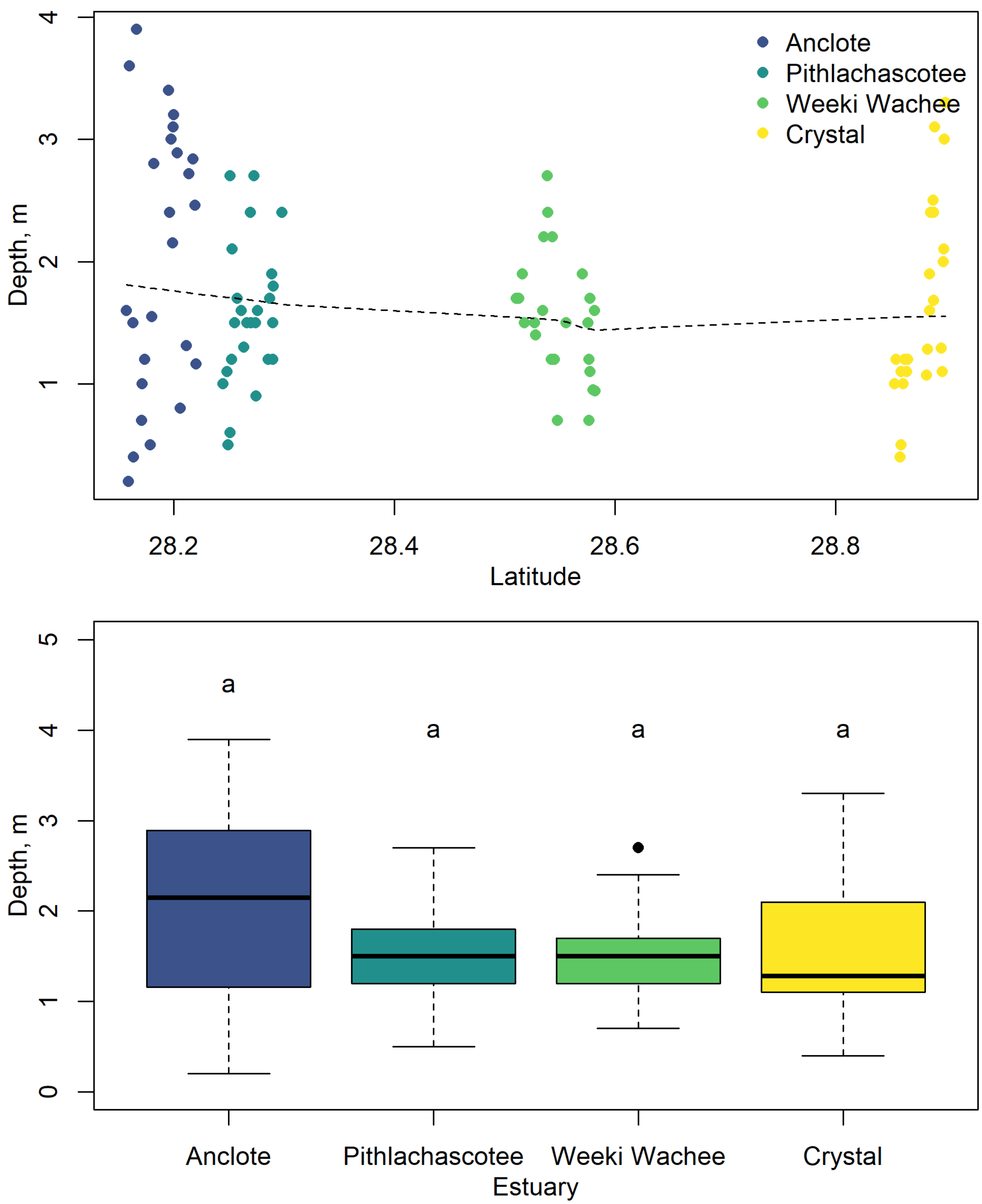

Figure 6 Water depth data collected during seagrass monitoring events in 2022. Letters above boxes in lower panel represent statistically significant groupings revealed by the Tukey's post-hoc comparisons.

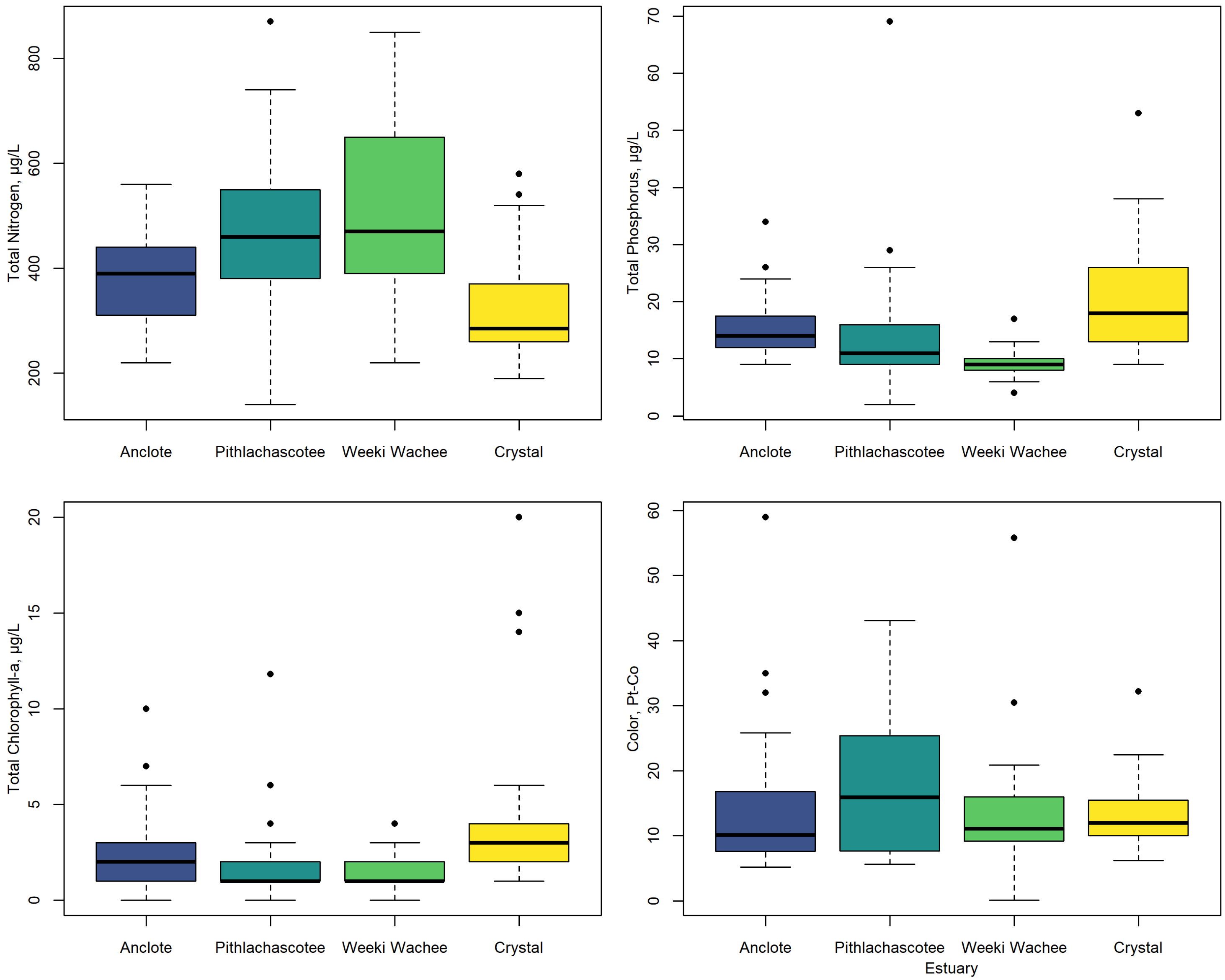

Figure 7. Data for (a) total nitrogen, (b) total phosphorus, (c) chlorophyll-a, and (d) color collected during Project COAST monitoring events from May 2021 - May 2022 at estuarine stations associated with SAV monitoring activities.

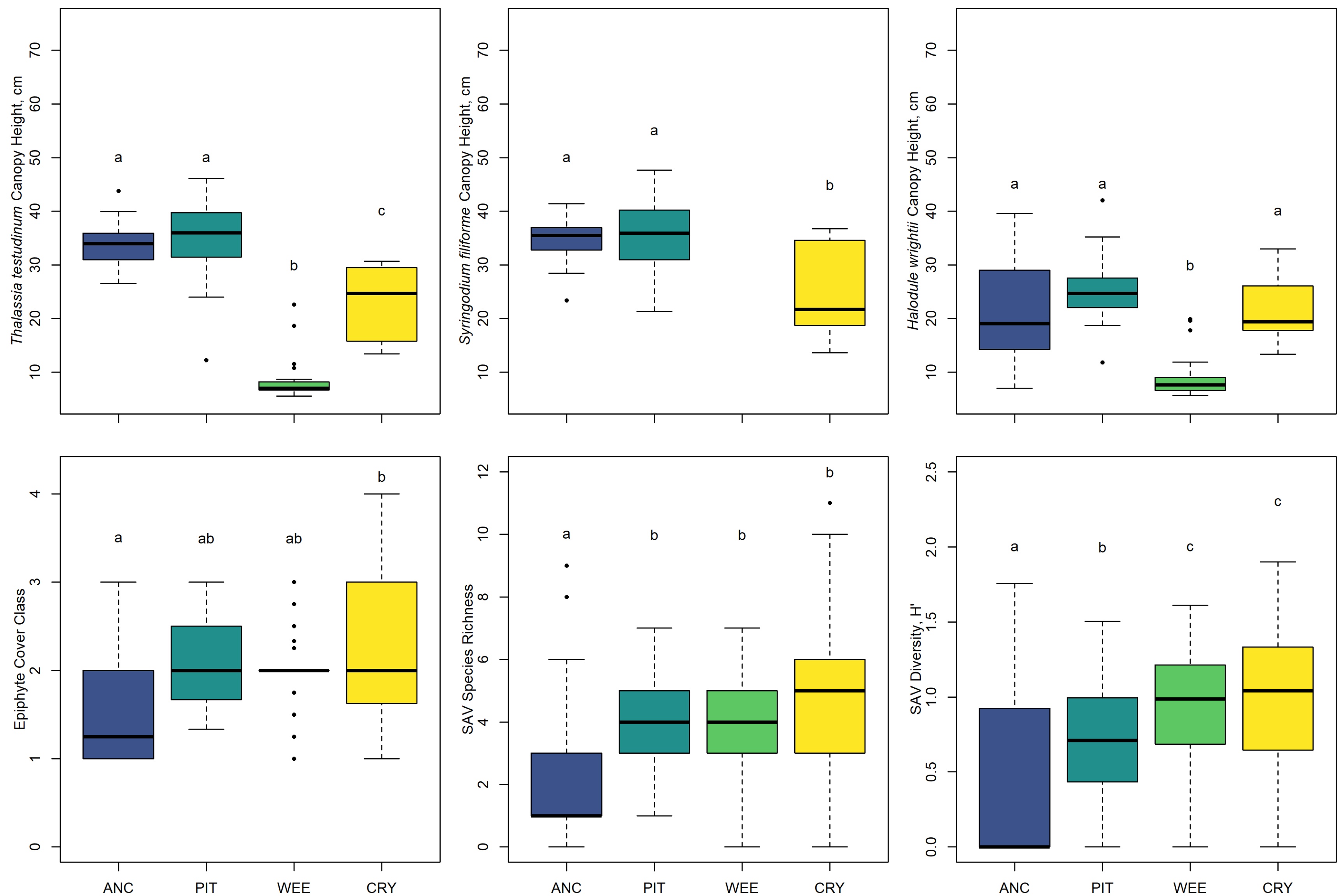

Figure 8. Data for canopy heights of (a) Thalassia testudinum, (b) Syringodium filiforme, and (c) Halodule wrightii and (d) epiphyte cover class, (e) SAV species richness, and (f) SAV species diversity collected during quadrat sampling activities associated with seagrass monitoring events in 2022. Letters above boxes in represent statistically significant groupings revealed by the Tukey's post-hoc comparisons. ANC = Anclote, PIT = Pithlachascotee, WEE = Weeki Wachee, CRY = Crystal River.

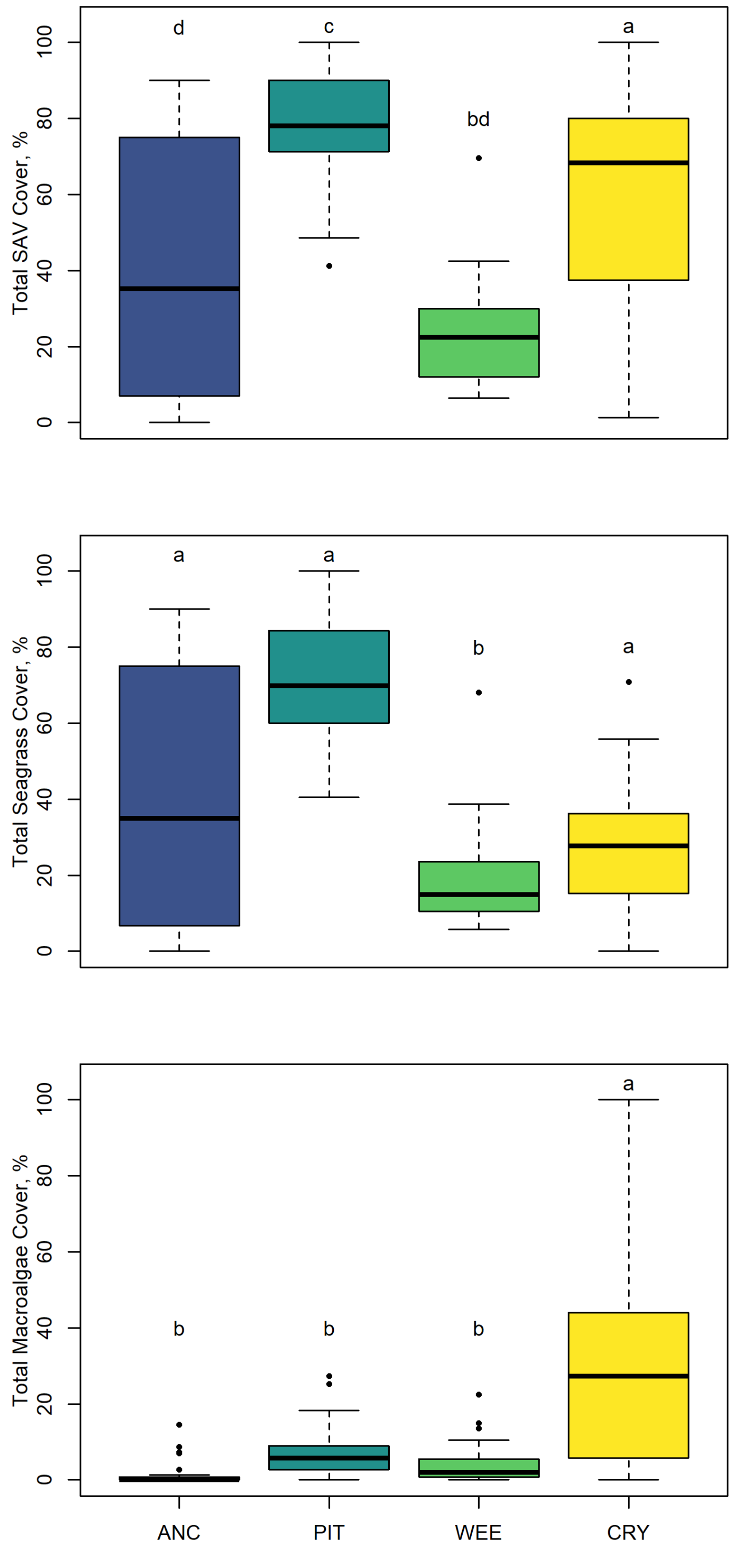

Figure 9. Mean percent cover for (a) total SAV, (b) seagrasses, and (c) attached macroalgae by system. Letters above boxes in lower panel represent statistically significant groupings revealed by the Tukey's post-hoc comparisons.

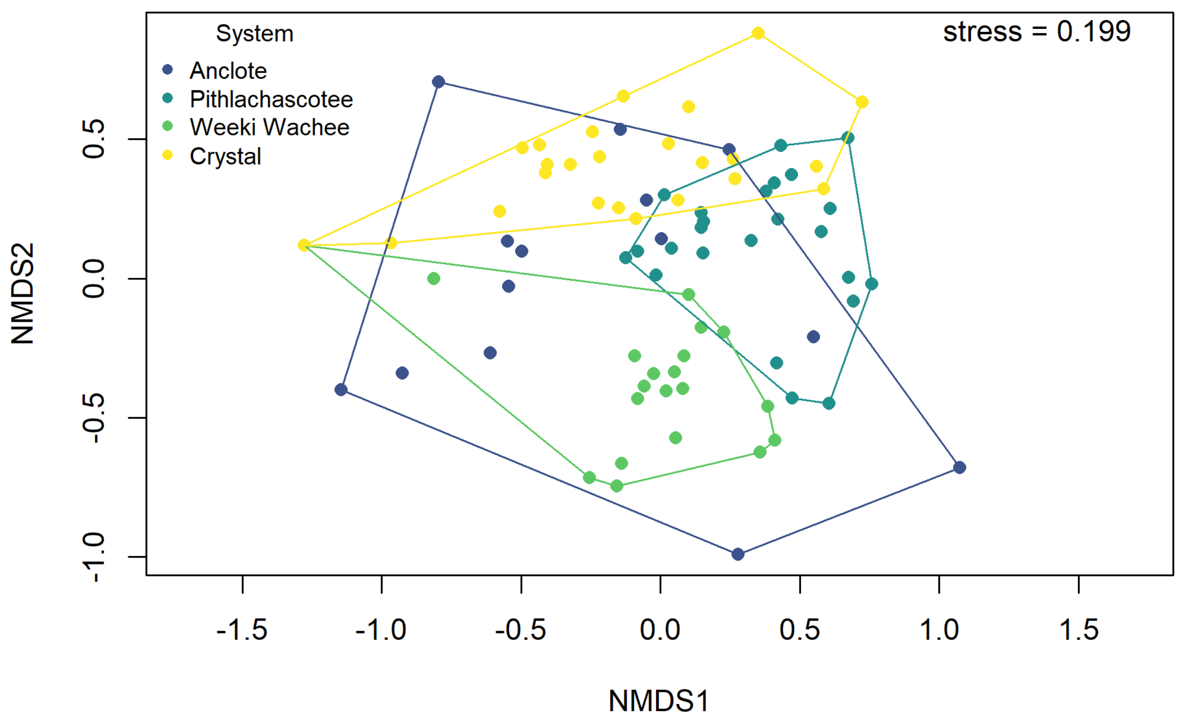

Figure 10. Visualization of the result of non-metric multidimensional scaling based on percent cover of SAV species found in quadrat sampling efforts in 2022.

Table 1. Sampling dates for each estuarine system studied in the NCAP seagrass monitoring program.

System	Assessment Dates
Crystal	June 2, and June 8-9, 2022
Weeki Wachee	June 1, 2022
Pithlachascotee	June 7 and June 13, 2022
Anclote	June 6, 2022

Table 2. List of species observed in each estuarine system, listed from north to south. The % column contains the number of quadrats out of 100 total in each system the species or condition was observed. Drift algae refers to any unattached macroalgae. Bare refers to quadrats that contained no vegetation of any kind.

	Crystal	%	Weeki Wachee	%	Pithlachascotee	%	Anclote	%
SEAGRASS	*Halodule wrightii*	56	*Thalassia testudium*	90	*Thalassia testudium*	94	*Halodule wrightii*	42
	Syringodium filiforme	40	*Halodule wrightii*	72	*Syringodium filiforme*	42	*Thalassia testudium*	36
	Thalassia testudium	40	*Halophila engelmannii*	4	*Halodule wrightii*	22	*Syringodium filiforme*	34
	Halophila engelmannii	31	*Ruppia maritima*	3	*Ruppia maritima*	3	*Halophila engelmannii*	1
	Ruppia maritima	10						
ALGAE	*Caulerpa prolifera*	77	*Batophora oerstedii*	67	Drift algae	69	Drift algae	48
	Drift algae	47	*Acetabularia crenulata*	49	*Caulerpa prolifera*	54	*Halimeda incrassata*	19
	Caulerpa pasploides	43	Drift algae	40	*Penicillus pyriformis*	38	*Caulerpa prolifera*	11
	Halimeda incrassata	23	*Penicillus dumetosus*	22	*Halimeda incrassata*	32	*Caulerpa ashmeadii*	10
	Penicillus capitatus	21	*Halimeda incrassata*	9	*Acetabularia crenulata*	22	*Penicillus dumetosus*	5
	Udotea flabellum	12	*Penicillus capitatus*	8	*Caulerpa pasploides*	20	*Acetabularia crenulata*	3
	Caulerpa ashmeadii	11	*Digenia simplex*	5	*Penicillus dumetosus*	7	*Anadyomene stellata*	2
	Acetabularia crenulata	10	*Penicillus pyriformis*	4	*Penicillus capitatus*	6	*Caulerpa lanuginosa*	2
	Digenia simplex	8	*Caulerpa pasploides*	3	*Batophora oerstedii*	3	*Penicillus capitatus*	2
	Penicillus pyriformis	8	*Anadyomene stellata*	2	*Caulerpa ashmeadii*	1	*Penicillus pyriformis*	2
	Penicillus dumetosus	7	*Caulerpa prolifera*	1	*Digenia simplex*	1	*Udotea flabellum*	2
	Sargassum spp.	6			*Sargassum* spp.	1	*Caulerpa cupressoides*	1
	Caulerpa cupressoides	2			*Udotea flabellum*	1	*Codium isthmocladum*	1
	Udotea spp.	1					*Digenia simplex*	1
							Sargassum spp.	1
BARE	Bare	3	Bare	1	Bare	1	Bare	23

Table 3. Mean percent coverages by estuarine system. Values presented are the overall means (calculated as the mean of station means) and standard deviations (SD) for total quadrat cover, seagrass cover, and macroalgal cover. Tukey's honestly squared differences test was performed on mean percent coverages for each station and results are displayed in the Tukey column. Letter codes indicate statistically significant groupings.

	Total SAV Cover			Seagrass Cover			Macroalgae Cover		
	Mean	SD	Tukey	Mean	SD	Tukey	Mean	SD	Tukey
Crystal River	57.7	26.5	a	26.3	17.8	a	31.4	30.7	a
Weeki Wachee	23.4	14.1	bd	18.8	13.0	a	4.7	5.9	b
Pithlachascotee	78.5	14.8	c	70.6	16.2	b	7.9	7.2	b
Anclote	38.6	34.0	d	36.9	33.3	a	1.7	3.4	b

Appendix A. SAV Monitoring Station Coordinates

County	System	Site Name	Latitude	Longitude
Citrus	Crystal	CC 9 SG 1	28.859480	-82.716141
Citrus	Crystal	CC 6 SG 2	28.897997	-82.710683
Citrus	Crystal	CC 6 SG 3	28.897794	-82.702097
Citrus	Crystal	CC 5 SG 4	28.898649	-82.741909
Citrus	Crystal	CC 6 SG 5	28.886270	-82.701999
Citrus	Crystal	CC 7 SG 6	28.896747	-82.682613
Citrus	Crystal	CC 8 SG 7	28.864454	-82.743348
Citrus	Crystal	CC 6 SG 8	28.888906	-82.710360
Citrus	Crystal	CC 8 SG 9	28.862635	-82.742445
Citrus	Crystal	CC 7 SG 10	28.882167	-82.674850
Citrus	Crystal	CC 6 SG 11	28.885220	-82.704132
Citrus	Crystal	CC 7 SG 12	28.883431	-82.673999
Citrus	Crystal	CC 9 SG 13	28.854700	-82.698530
Citrus	Crystal	CC 5 SG 14	28.889566	-82.732270
Citrus	Crystal	CC 9 SG 15	28.858518	-82.714656
Citrus	Crystal	CC 8 SG 16	28.865530	-82.741780
Citrus	Crystal	CC 7 SG 17	28.888878	-82.686312
Citrus	Crystal	CC 8 SG 18	28.859532	-82.737164
Citrus	Crystal	CC 5 SG 19	28.899454	-82.741062
Citrus	Crystal	CC 9 SG 20	28.853264	-82.703508
Citrus	Crystal	CC 5 SG 21	28.885210	-82.739859
Citrus	Crystal	CC 7 SG 22	28.895626	-82.669350
Citrus	Crystal	CC 5 SG 23	28.888340	-82.743853
Citrus	Crystal	CC 9 SG 24	28.864857	-82.714982
Citrus	Crystal	CC 8 SG 25	28.860975	-82.737169
Hernando	Weeki Wachee	HW 5 SG 1	28.576676	-82.655327
Hernando	Weeki Wachee	HW 10 SG 2	28.581499	-82.696500
Hernando	Weeki Wachee	HW 7 SG 3	28.528268	-82.669447
Hernando	Weeki Wachee	HW 4 SG 4	28.544967	-82.649129
Hernando	Weeki Wachee	HW 4 SG 5	28.535643	-82.661505
Hernando	Weeki Wachee	HW 5 SG 6	28.577313	-82.663909
Hernando	Weeki Wachee	HW 4 SG 7	28.542473	-82.650785
Hernando	Weeki Wachee	HW 6 SG 8	28.555818	-82.684801
Hernando	Weeki Wachee	HW 10 SG 9	28.575614	-82.687298
Hernando	Weeki Wachee	HW 4 SG 10	28.547859	-82.662072
Hernando	Weeki Wachee	HW 8 SG 11	28.512946	-82.693748

Hernando	Weeki Wachee	HW 9 SG 12	28.543183	-82.691831
Hernando	Weeki Wachee	HW 7 SG 13	28.518105	-82.678230
Hernando	Weeki Wachee	HW 5 SG 14	28.579947	-82.665476
Hernando	Weeki Wachee	HW 5 SG 15	28.581887	-82.657953
Hernando	Weeki Wachee	HW 8 SG 16	28.510599	-82.691729
Hernando	Weeki Wachee	HW 10 SG 17	28.570336	-82.695170
Hernando	Weeki Wachee	HW 5 SG 18	28.576564	-82.668855
Hernando	Weeki Wachee	HW 9 SG 19	28.538618	-82.700962
Hernando	Weeki Wachee	HW 9 SG 20	28.534664	-82.686150
Hernando	Weeki Wachee	HW 8 SG 21	28.512694	-82.696361
Hernando	Weeki Wachee	HW 8 SG 22	28.515987	-82.687423
Hernando	Weeki Wachee	HW 9 SG 23	28.539394	-82.685461
Hernando	Weeki Wachee	HW 10 SG 24	28.577298	-82.694695
Hernando	Weeki Wachee	HW 7 SG 25	28.527004	-82.673199
Pasco	Pithlachascotee	PP 7 SG 1	28.285702	-82.743511
Pasco	Pithlachascotee	PP 6 SG 2	28.288875	-82.766622
Pasco	Pithlachascotee	PP 3 SG 3	28.276304	-82.756353
Pasco	Pithlachascotee	PP 6 SG 4	28.298333	-82.770561
Pasco	Pithlachascotee	PP 3 SG 5	28.269979	-82.758524
Pasco	Pithlachascotee	PP 4 SG 6	28.261458	-82.771608
Pasco	Pithlachascotee	PP 7 SG 7	28.289984	-82.755035
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Pasco	Pithlachascotee	PP 8 SG 17	28.257605	-82.773066
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Pasco	Pithlachascotee	PP 10 SG 19	28.252885	-82.786485
Pasco	Pithlachascotee	PP 3 SG 20	28.274356	-82.756436
Pasco	Pithlachascotee	PP 4 SG 21	28.266275	-82.766884
Pasco	Pithlachascotee	PP 7 SG 22	28.287030	-82.753344
Pasco	Pithlachascotee	PP 9 SG 23	28.249625	-82.753185
Pasco	Pithlachascotee	PP 9 SG 24	28.251373	-82.758664
Pasco	Pithlachascotee	PP 8 SG 25	28.248430	-82.761147
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Pasco	Anclote	PAN 8 SG 5	28.196208	-82.837614
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Pasco	Anclote	PAN 9 SG 7	28.219584	-82.802325
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Pasco	Anclote	PAN 1 SG 13	28.174002	-82.808265
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Pasco	Anclote	PAN 4 SG 19	28.182187	-82.821533
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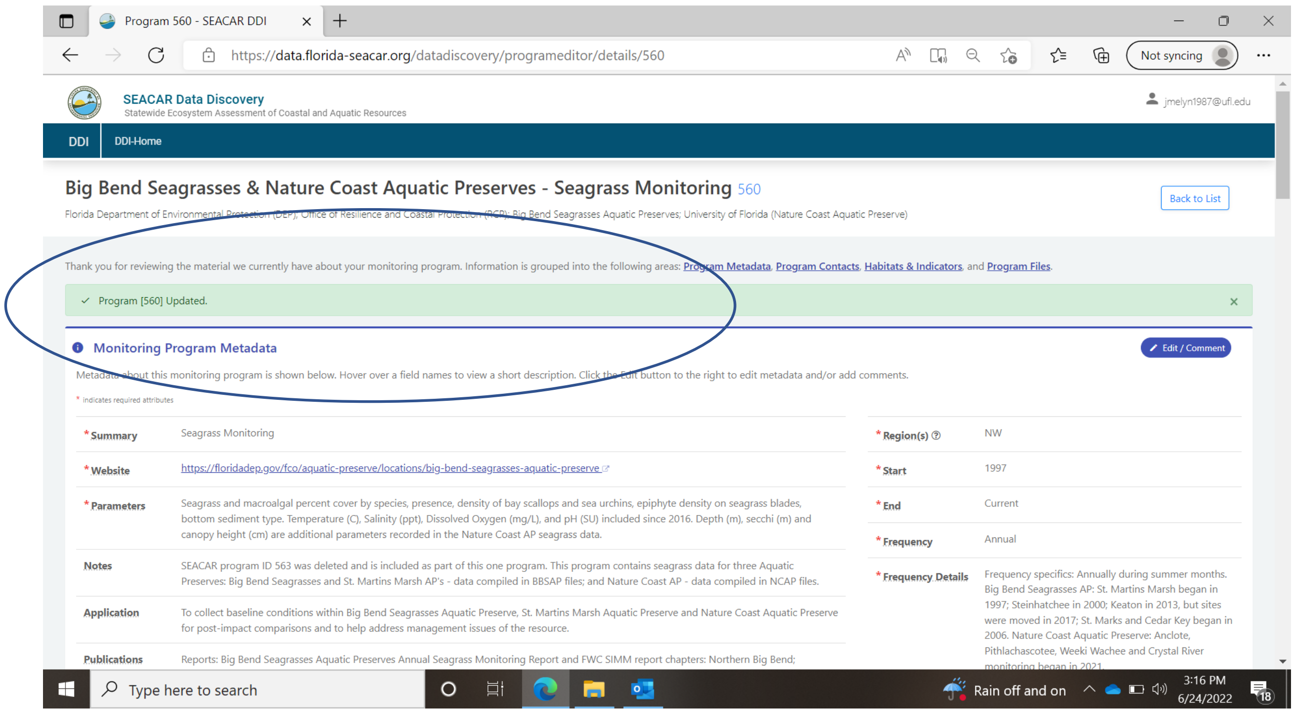
Pasco	Anclote	PAN 10 SG 21	28.211658	-82.783221
Pasco	Anclote	PAN 7 SG 22	28.157242	-82.810786
Pasco	Anclote	PAN 10 SG 23	28.220440	-82.772124
Pasco	Anclote	PAN 6 SG 24	28.163855	-82.843079
Pasco	Anclote	PAN 8 SG 25	28.199256	-82.835326

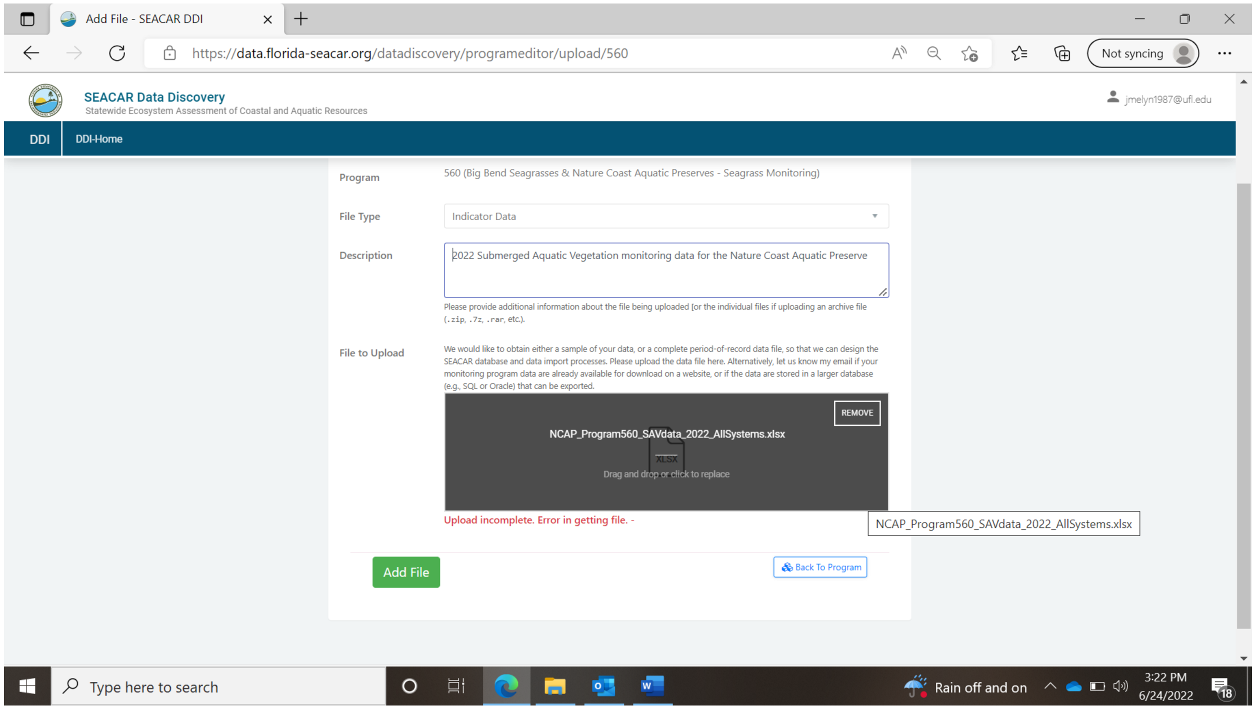
Appendix B. Statewide Ecosystem Assessment of Coastal and Aquatic Resources Data Discovery Interface Upload

Program 560 – Big Bend Seagrasses & Nature Coast Aquatic Preserves – Seagrass Monitoring

NCAP Seagrass Monitoring Program Page Update – The preexisting page for **Program 560 – Big Bend Seagrasses Aquatic Preserves – Seagrass Monitoring** has been updated to include Nature Coast Aquatic Preserve information. Various updates have been made throughout the text of this program page to represent the change in protocol from Braun Blanquet to Percent Cover methods.



NCAP Seagrass Monitoring Data Upload – Nature Coast Aquatic Preserve Seagrass Monitoring data has been uploaded to the SEACAR DDI as file name "**NCAP_Program560_SAVdata_2022_AllSystems**" following the BBSAP file naming format. This file mirrors the exact layout as the BBSAP file, except for columns added for drift_% and canopy heights. Water quality parameters recorded at each station were also removed and recorded in their own tab within the worksheet and now includes secchi depth for each station. The definitions tab has also been updated to reflect these changes.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https://data.florida-seacar.org/datadiscovery/programeditor/upload/560
Not syncing
SEACAR Data Discovery
Statewide Ecosystem Assessment of Coastal and Aquatic Resources
jmelyn1987@ufl.edu
DDI
DDI-Home
Program
560 (Big Bend Seagrasses & Nature Coast Aquatic Preserves - Seagrass Monitoring)
File Type
Indicator Data
Description
2022 Submerged Aquatic Vegetation monitoring data for the Nature Coast Aquatic Preserve
Please provide additional information about the file being uploaded [or the individual files if uploading an archive file (.zip, .7z, .rar, etc.).
File to Upload
We would like to obtain either a sample of your data, or a complete period-of-record data file, so that we can design the SEACAR database and data import processes. Please upload the data file here. Alternatively, let us know my email if your monitoring program data are already available for download on a website, or if the data are stored in a larger database (e.g., SQL or Oracle) that can be exported.
REMOVE
NCAP_Program560_SAVdata_2022_AllSystems.xlsx
Drag and drop or click to replace
Upload incomplete. Error in getting file. -
NCAP_Program560_SAVdata_2022_AllSystems.xlsx
Add File
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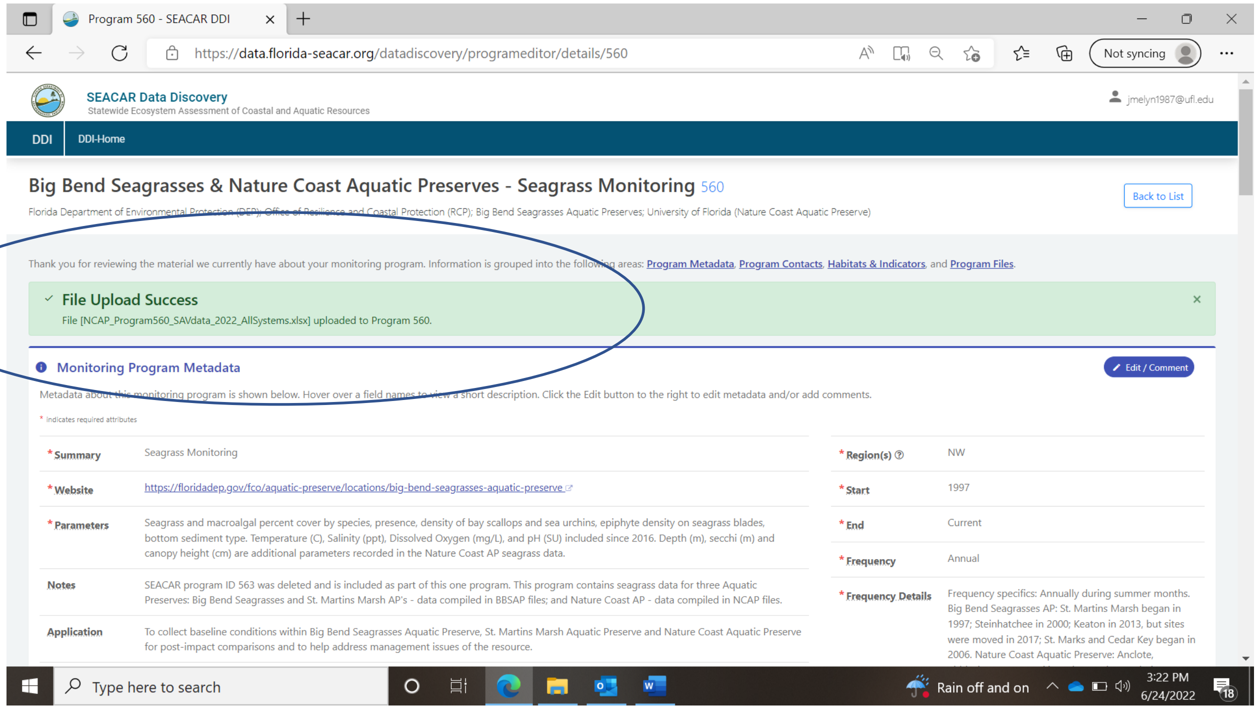
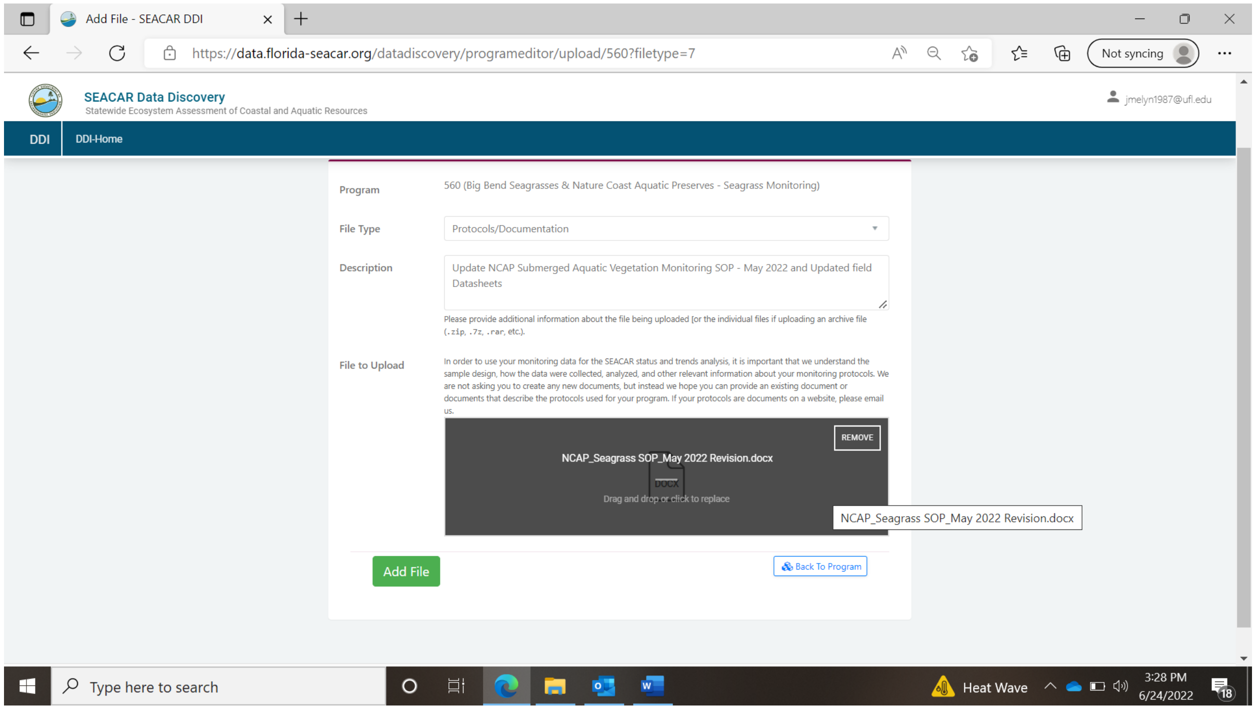


NCAP Seagrass Monitoring SOP and Datasheet Upload – Updated SOP has been created for this program. This file has been uploaded, including the most up to date version of the field datasheets.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https://data.florida-seacar.org/datadiscovery/programeditor/upload/560?filetype=7
Not syncing
SEACAR Data Discovery
Statewide Ecosystem Assessment of Coastal and Aquatic Resources
jmelyn1987@ufl.edu
DDI
DDI-Home
Program
560 (Big Bend Seagrasses & Nature Coast Aquatic Preserves - Seagrass Monitoring)
File Type
Protocols/Documentation
Description
Update NCAP Submerged Aquatic Vegetation Monitoring SOP - May 2022 and Updated field Datasheets
Please provide additional information about the file being uploaded (or the individual files if uploading an archive file (.zip, .7z, .rar, etc).
File to Upload
In order to use your monitoring data for the SEACAR status and trends analysis, it is important that we understand the sample design, how the data were collected, analyzed, and other relevant information about your monitoring protocols. We are not asking you to create any new documents, but instead we hope you can provide an existing document or documents that describe the protocols used for your program. If your protocols are documents on a website, please email us.
REMOVE
NCAP_Seagrass SOP_May 2022 Revision.docx
Drag and drop or click to replace
NCAP_Seagrass SOP_May 2022 Revision.docx
Add File
Back To Program
Type here to search
Heat Wave
3:28 PM
6/24/2022

Program 560 - SEACAR DDI

https://data.florida-seacar.org/datadiscovery/programeditor/details/560

Not syncing

SEACAR Data Discovery
Statewide Ecosystem Assessment of Coastal and Aquatic Resources

jmelyn1987@ufl.edu

DDI | DDI-Home

Big Bend Seagrasses & Nature Coast Aquatic Preserves - Seagrass Monitoring 560

Florida Department of Environmental Protection (DEP); Office of Resilience and Coastal Protection (RCP); Big Bend Seagrasses Aquatic Preserves; University of Florida (Nature Coast Aquatic Preserve)

Back to List

Thank you for reviewing the material we currently have about your monitoring program. Information is grouped into the following areas: Program Metadata, Program Contacts, Habitats & Indicators, and Program Files.

✓ **File Upload Success**
File [NCAP_Seagrass SOP_May 2022 Revision.docx] uploaded to Program 560.

Monitoring Program Metadata

Edit / Comment

Metadata about this monitoring program is shown below. Hover over a field names to view a short description. Click the Edit button to the right to edit metadata and/or add comments.

* Indicates required attributes

* **Summary**	Seagrass Monitoring
* **Website**	https://floridadep.gov/fco/aquatic-preserve/locations/big-bend-seagrasses-aquatic-preserve
* **Parameters**	Seagrass and macroalgal percent cover by species, presence, density of bay scallops and sea urchins, epiphyte density on seagrass blades, bottom sediment type. Temperature (C), Salinity (ppt), Dissolved Oxygen (mg/L), and pH (SU) included since 2016. Depth (m), secchi (m) and canopy height (cm) are additional parameters recorded in the Nature Coast AP seagrass data.
Notes	SEACAR program ID 563 was deleted and is included as part of this one program. This program contains seagrass data for three Aquatic Preserves: Big Bend Seagrasses and St. Martins Marsh AP's - data compiled in BBSAP files; and Nature Coast AP - data compiled in NCAP files.
Application	To collect baseline conditions within Big Bend Seagrasses Aquatic Preserve, St. Martins Marsh Aquatic Preserve and Nature Coast Aquatic Preserve for post-impact comparisons and to help address management issues of the resource.

* **Region(s)**	NW
* **Start**	1997
* **End**	Current
* **Frequency**	Annual
* **Frequency Details**	Frequency specifics: Annually during summer months. Big Bend Seagrasses AP: St. Martins Marsh began in 1997; Steinhatchee in 2000; Keaton in 2013, but sites were moved in 2017; St. Marks and Cedar Key began in 2006. Nature Coast Aquatic Preserve: Anclote,

Type here to search

Ongoing alert 3:29 PM 6/24/2022